each of genera living today (2 n = 62). From these 3 AC pairs (A, B, C) might have arisen – through a simple centromeric (Robertsonian) fusion – the chromosomes typical of *Andrias* (B + C, A) or those of *Cryptobranchus* (A + B, C) (figure 7).

During the evolution of Caudates, the karyotype seems to have differentiated by a progressive reduction in the number of the chromosomes, notably ACs and microchromosomes, due perhaps to centric fusions or other mutational events[10]. From this standpoint, the Cryptobranchids do not appear the most primitive forms of the order, karyologically, since within Hynobiids some species have more than 60 chromosomes[10]. Among these, *Ranodon sibiricus* (2 n = 66) is likely to be the species karyologically closest to the 2 living Cryptobranchids[14]. It is of interest to note that *Ranodon*, owing to various characteristics of its development, is regarded as the most primitive genus within the Hynobiids[15]. In view of the fact that the Cryptobranchids probably represent a paedogenetic derivation from ancient Hynobiids[2–4], a hypothetical ancestral form common to *Andrias* and *Cryptobranchus* may have been equipped with a chromosome set of more than 60 elements, though nearly akin enough to the set of the 2 extant genera, so as to be able to turn into it with a minimum number of chromosome mutations. (These urodeles are in fact likely to be bradytelic also from a karyological point of view.)

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Interchange trisomics in pearl millet

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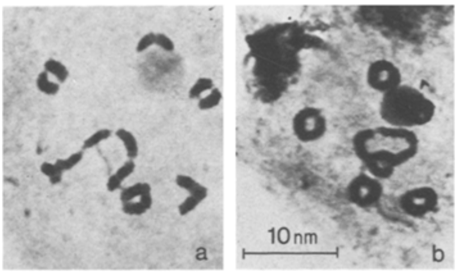
Summary. In the progeny of interchange heterozygotes of *Pennisetum typhoides*, 2 interchange trisomic plants were obtained. These were selfed over 2 generations and the cytology of the parents, s_1 and s_2 plants was studied. The types of multiple associations in the s_1 and s_2 generations differed from those of the parent. A significant decrease in mean chiasma frequency was noted in s_1 and s_2.

The term interchange trisomic applies to a situation where an extra chromosome occurs in an interchange background. If the extra chromosome consists of 2 arms of 2 nonhomologous chromosomes, it is known as a tertiary trisomic. Both interchange and tertiary trisomics can be obtained in the progeny of a translocation heterozygote. These 2 types of trisomics can be distinguished from one another by their characteristic chromosome associations. In the tertiary trisomics, when the extra chromosome is present as a univalent, the other chromosomes will be in pairs and the critical configuration is the dumbbell-shaped association of 5 chromosomes, viz. 2 ring bivalents attached to a single middle chromosome, whereas in an interchange trisomic besides associations of 5 chromosomes, a univalent and a ring of 4 are expected to occur. Interchange trisomics were previously reported in a number of plants, e.g. maize[2], Pisum[3], barley[4]. In these cases, they were obtained in the progeny of translocation heterozygotes.



Types of associations of chromosomes in the interchange trisomics at diakinesis. [a] PMC showing 1 chain of 4 chromosomes, 5 bivalents and a univalent. [b] PMC showing frying pan type (1 trivalent attached to a ring bivalent) association of 5 chromosomes and 5 bivalents.

Results and conclusions. In *Pennisetum typhoides* S. & H. (Gramineae) in the progeny of interchange heterozygotes, 2 plants with the chromosome number 2n = 15 instead of the normal 2n = 14 were obtained. A study of PMC meiosis in these plants was carried out and a dumbbell-shaped association of 5 chromosomes was never observed. Further, when the extra chromosome was present as a univalent, a ring of 4 chromosomes was frequently observed indicating translocation background of this aneuploidy.

In an interchange trisomic of this type, there are 2 completely homologous chromosomes and 2 interchange chromosomes. The 5th chromosome is a normal one and is homologous to one of the chromosomes involved in the translocation. Under these conditions, a total of 9 types of pachytene configurations can be formed which result in 9 groups of configurations at diakinesis and metaphase I. These are possible only under 2 conditions: a) chromosome pairing is initiated exclusively at the chromosome ends; b) the 3 ends have equal probability of being involved in pairing. When there are no interstitial chiasmata, these 9 types will consist of 6 as chains of 5 chromosomes, 1 as chain of 3 chromosomes plus ring bivalent, and 2 each as a ring of 4 chromosomes and a univalent[7]. The data relating to the types of associations observed at diakinesis are presented in the table. Among the PMC's examined, 54% showed associations of 5

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Types and frequencies of multivalent associations and chiasma frequency at diakinesis in the parent, S_1 and S_2 plants

Plant	Association of 5 chromosomes				4 chromosomes		Trivalents	Bivalents Ring	Rod	Univalents	Chiasma frequency Mean	Variance	Total No. of cells
	*8	11	13	18	6	17	4						
Parent interchange trisomic	34	2	12	6	10	8	28	408	120	18	12.68	0.7375	100
s_1	126	–	–	3	6	9	6	534	213	33	12.40	0.6845	150
s_2	80	–	–	–	6	24	40	612	128	130	12.32	0.6577	150

* Numbers refer to the types of configurations given by Sybenga[5].

chromosomes besides 5 bivalents; 18% showed a ring of 4 or chain of 4 and a univalent (figure a). In addition to the different types of configurations observed, a few others occurred which were the consequence of the presence of interstitial chiasmata and pairing initiation. From the data of the configurations at diakinesis, it is possible to assess preferential pairing, if present. 1 type of association resulting from preferential pairing is a trivalent with a ring bivalent (figure b). The frequency of this configuration is very low (3.7%) indicating that preferential pairing is practically absent in this material. The orientation of the multiple associations at metaphase I was studied. The association of 5 was alternate in 18% of the cases, adjacent in 24% and linear in 10%. Association of 4 chromosomes was alternate in 4%, adjacent in 14% of the cells. Among the trivalents, adjacent orientation was observed in 18%, linear in 12% and alternate in 2% of the cells. At anaphase I the distribution of chromosomes was 7–8. In 2% of the cells, 1 lagging chromosome was observed. The second division was normal. The 2 interchange trisomics were selfed and their s_1 and s_2 progenies were raised. A comparative study of the cytology of the s_1 and s_2 and the parental interchange trisomics was attempted with a view to assess the effect of inbreeding on the types of multiple associations and the mean chiasma frequency. The following features are observed (table): in the parents, the bivalent frequency was low when compared to the s_1 and s_2 generations. This might be due to the higher chiasma frequencies in the parent. This difference is significant at the 5% level.

In the parent, multivalent associations showing higher chiasma numbers were observed, whereas in the s_1 and s_2 generations the associations of 5 or 4 chromosomes were predominantly of chain types. In the s_1 and s_2 generations, the orientation of the multiple associations at metaphase I was adjacent or linear, alternate orientation being observed in 4% of the cells only in s_1. The pollen fertility in the parents, s_1 and s_2 was 58, 42 and 38% respectively. Inbreeding leads to reduced chiasma frequency and occurrence of meiotic abnormalities. This effect has been previously reported for *Pennisetum typhoides*[6,8]. In the present study, inbreeding for 1 and 2 generations has produced a significant difference in the mean chiasma frequencies, and a change in the types and frequencies of multiple associations.

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Biochemical variation in the *Rana esculenta* complex: A new hybrid form related to *Rana perezi* and *Rana ridibunda*

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Summary. Investigations of the green frogs from western Europe for electrophoretic variations at 4 enzyme loci demonstrated a new form which must be considered as a hybrid between *Rana ridibunda* and *R. perezi*. Biochemical evidence supports the hypothesis that its reproduction is hybridogenetic, as it is for *R. esculenta*.

The common European green frog, *Rana esculenta* Linnaeus 1758, has been shown to result from natural hybridization between *Rana ridibunda* Pallas 1771 and *Rana lessonae* Camerano 1882[1–8]. Breeding experiments, as well as morphological and genetic evidence, indicate that little or no introgression occurs between the 2 species[2,5–7]. Furthermore, they suggest that R. esculenta, reproductively speaking, is virtually a R. ridibunda. As a matter of fact, the cross ridibunda × esculenta produces exclusively ridibunda offsprings, while the cross escu-

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